A Nonmonopoly Theory of Union Wages and Hours Worked

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ABSTRACT. An extensive literature review considers the union voice effect on firm performance. A theoretical model of labor demand under uncertainty is developed that hypothesizes a linkage between firm performance and the union voice effect. The model generates a positive union effect on wages and hours worked without union monopoly power. The model provides a more detailed conceptual framework for explaining why the union voice effect may improve efficiency within the firm than that currently found in the literature (J30, J50).

I. Introduction

The economics of labor union activity on wages, productivity, and market efficiency has been a tug of war among economists for decades. The battle line is drawn over the controversy surrounding the issue of labor union market power versus increased labor productivity attributed to the organizational benefits bestowed upon workers associated with unions.

Our intention is to address only one aspect of this controversy. We explore the economic implications of increased marginal productivity due to decreased uncertainty over the flow of factor services (Walters 1960) within the context of the "Union Voice Hypothesis."

We begin our discussion with an in-depth review of the literature on the economics of labor unions. We then develop a stochastic model of firm behavior under the assumption the firm is operating in a competitive environment that has the option of hiring union or nonunion labor. The model demonstrates that if it is assumed that nonunion labor has greater uncertainty over the flow of factor services relative to union labor, then both average and marginal productivity of nonunion labor will be lower than union labor. It is assumed that unionization of labor reduces uncertainty over the flow of labor services i.e., a union voice effect. As

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a consequence, wages and hours worked will be higher for union labor.

II. Literature Review

A. BACKGROUND

Labor unions have been a contentious issue in the economics literature. The traditional view is that unions act as a labor monopolist to control compensation (wages and benefits) and employment conditions (Dunlop, 1944; Fellner, 1949; Cartter, 1959). Monopoly power is viewed as an undisputed source of market inefficiency. Unions use their monopoly power to raise union sector wages above competitive market wages.[1] Assuming a downward sloping labor demand curve, union sector employment declines and labor resources shift to the nonunion sector. The increase in nonunion labor supply further suppresses nonunion sector wages. Additionally, the tradition view perceives union contracts as a means to impose restrictive contract provisions to limit union member work loads and impose featherbedding tactics to reduce substitution of new technology for union employment. Strikes and strike threats are used to impose union demands on management. In the advent of strikes, society is penalized by a reduction in aggregate production. Union sector firms pass the higher production costs from union wages and restrictive contracts onto consumers by raising market prices. Moreover, unions typically target firms with highly profitable products since their market demand curves are typically more inelastic than firms producing in highly competitive product markets. By raising union sector production costs, additional market inefficiencies result as productive resources are also diverted from high valued products to lesser valued production in the nonunion sector. Thus, unions bestow economic rents on their members at the expense of the rest of society. Lewis (1986) reviews approximately 200 empirical studies and finds a union/nonunion wage differential in the range of 15%.

Opposing views have considered unions and the collective bargaining system as means to counteract employer power over the individual employee (Ross, 1948). Collective bargaining is viewed by union protagonists as a means to promote industrial jurisprudence as well as to increase wages and benefits. Fair employment conditions that affect the well-being of workers have a "public goods" aspect in that all workers benefit from formal work rules rather than managerial decisions based on

arbitrary discretion or personal favoritism. Unions establish and enforce rules on promotion, layoff, and rehiring; and workplace conditions such as the rate of production, assigned duties, and safety. They also provide a system of industrial jurisprudence through which workers voice and resolve their industrial relations problems through formal grievance and arbitration procedures. The union can more easily communicate more efficient ways to perform work related tasks to the employer. Without collective bargaining to offset employer negotiating power over the employment contract, individual employees would assume risk of employer retaliation or dismissal from expressing preferences or protesting workplace conditions. Nonunion workers, having no means (or power) to effectively voice their labor-management disputes, must utilize a market response system and exit the firm.

B. UNION VOICE EFFECT

While the monopoly view of unionism is prevalent in the literature, Freeman and Medoff (1984) argue that unions may be a source of increased economic efficiency. They view unions as having two faces: 1) the desirable side is the collective voice-institutional response (CV-IR) of unions, and 2) the undesirable side is union monopoly power. Freeman and Medoff (F&M) claim that the union voice effect or CV-IR role of unions fundamentally changes the functioning of the labor market. In the nonunion sector labor market, employee exit and entry decisions are based on the preferences of the marginal worker who is typically younger and less experienced. In the union sector, labor contracts are negotiated based on the preferences of their membership (for example, the median voter model (Mueller, 1989; Oswald, 1993)). Collective bargaining agreements, consequently, reflect the preferences of more senior, "infra-marginal" workers. Union firms utilize compensation packages (tradeoff of wages for benefits) and personnel practices that implement seniority rules to determine promotion, layoffs, and recalls.

F&M argue that the CV-IR aspect of unions results in workers having lower quit rates. Union firms benefit from lower turnover rates relative to nonunion firms and therefore higher levels of workforce tenure. Given the higher retention rate, a unionized work force will, on average, maintain a greater firm-specific skill set, which increases firm efficiency. Union workers may be more willing than nonunion workers to facilitate the introduction of new management technologies utilizing employee

involvement or high performance work practices (like self-managed work teams and cooperative management teams). A lower quit rate has the additional benefit of reducing replacement hiring and training costs. Due to efficiency gains from CV-IR (i.e., the "good face" of unions), union firms may experience labor productivity gains sufficient to offset the higher level of union wages.

C. UNION VOICE EFFECT ON TURNOVER

The assertion by F&M that productivity gains from CV-IR can potentially offset the union/nonunion wage differential has been roundly disputed in the economics literature. This suggests that a unionized workforce must induce greater efficiency that results in a sizable productivity effect to offset higher union wage costs.

One possible avenue for this potential positive union effect is employee turnover. A number of studies (Freeman (1980), Campbell (1994, 1997), Miller and Mulvey (1991), Addison, Schnabel, and Wagner (2001), Addison and Belfield (2001), Batt et al. (2002)) suggest that unions significantly reduce turnover and increase employment tenure. Reduction in turnover appears to be directly related to the union voice mechanism. The key issue in the literature is whether reducing quits significantly influences labor productivity. Mefford (1986), using plant level data of a single multinational manufacturing firm, found that lower turnover rates in union plants had sizable and significant positive impact on plant productivity (nonunion plants do not receive a productivity gain from lower turnover). Mefford argues that a lower turnover rate improves productivity only in the union sector because of the higher quality attributes of union workers.[2] Mefford also finds a higher absenteeism rate for union workers, but it does not have a significant effect on union sector productivity.

D. UNION VOICE EFFECT AND HIGH EFFICIENCY WORK SYSTEMS

Another avenue of X-efficiency gain from CV-IR is improvement in information flow and cooperation between workers and management. Union workers may be less resistant to the introduction of new management and production technologies if they are assured of capturing their portion of the productivity gain under a collective bargaining

agreement. The greater union sector job security reduces the reluctance of workers to share information on labor saving innovations. Senior workers would also be more willing to share firm-specific skills with younger workers.

With intensifying domestic and global competition, unions are venturing into collective bargaining contacts that emphasize employee involvement or high performance work systems (HPWS). The "new era" union/management cooperation concentrates on collaborative efforts to increase economic efficiency. In this new era, "good" unions are willing to trade wage bill maximization for long-run employment stability. Management (in some cases) has lauded this new era of cooperativeness where unions have helped improve productivity by endorsing new technology and innovative production systems such as self-managed work-place teams (Bernstein (1994), Cooke (1994), Black and Lynch (2001)).

Alternative views are that the F&M CV-IR argument overstates the communication role unions have with management. Lewin (2005) argues that unions primarily operate to offset the power imbalance between employers and employees. Lewin argues that unions have become anachronistic in a modern human relations environment. Lewin claims that the advancement in nonunion human resource management, legislation, and court ruling has fundamentally changed labor relations to the degree that workers no longer need unions to equalize the employer's power in employment contracts. Since workers no longer need collective bargaining power, Lewin posits that this evolution in industrial relations has led to the sharp decline in union sector employment over the last two decades.

E. UNION VOICE EFFECT AND LABOR PRODUCTIVITY

The argument that union firms have greater productivity than nonunion firms is controversial. A number of empirical studies support a positive effect of unions on productivity (Brown and Medoff (1978), Clark (1980a; 1980b), Allen (1984a; 1986; 1987), Boal (1990), Mefford (1986)), however, empirical evidence indicates that the effect is small at best and insufficient to offset the larger union wage rates. A meta-analysis by Doucouliagos and Larouche (2003) finds that the mean effect of unions on productivity in US manufacturing is 3% to 6% (depending on the weighting of the different empirical studies in the meta-regression

analysis).[3] The mean productivity effect, however, is insufficient to offset the average union wage differential of 15% reported in the literature. Addison and Hirsch (1989) and Kuhn (1998) reach similar conclusions.[4] A number of studies have also found negative productivity effects (Clark (1984), Hirsch and Link (1984), Hirsch and Addison (1986), Hirsch (1990a), Bemmels (1987)). Given the inherent problems in estimating productivity from aggregate manufacturing data, studies at the specific industry level are likely to have more trustworthy results since they compare firms that produce similar goods and use similar technology.

F. UNION VOICE EFFECT, FIRM PROFITABILITY, AND RISK

The issue of union productivity has ramifications on the cost of production and profitability. Union firms that are unable to offset higher wages with greater productivity will have lower profitability. F&M argue that the profit rate is lower only for union firms in highly concentrated industries, where the reduced profit rate reflects unions sharing economic rents with firms that have extensive market power. Clark (1984) finds that the profit rate is lower in more competitive industries with lower concentration ratios while profits are unaffected in highly concentrated industries. Firms without substantial market power are less able to increase prices to offset higher union wage rates. Hirsch and Connolly (1994) and Hirsch (1990a) argue that union sector profitability is unrelated to concentration ratios and that the union capture of firm profits is associated with firm specific market advantages, R&D investments in long-lived capital, and weak foreign competition. Chapell et al (1991) find that the lower union firm profitability is uniform across industries with low, medium, and high concentration ratios. Chapell et al conclude that unions have a greater impact on the profits of larger than smaller firms. Ruback and Zimmerman (1984) and Abowd (1989) find that stock values fall with newly certified unions and reflect a shareholder wealth transfer to union workers due to higher labor costs. The lack of a union productivity gain sufficient to offset union wage premiums and the negative union effect on profitability of 10 to 15 percent strongly suggest that unions operate as pure rent seekers by applying a union "tax" on shareholder wealth and earning.[5]

A series of articles beginning with Becker and Olson (1989) investigate differences in firms' returns adjusted for risk.[6] Becker and Olson use firm level data from 1970 through 1981 and calculate the firm's

union coverage rate. They estimate the firm's beta value (or measure of systematic risk) for 1971 through 1981 and find that union firms have significantly lower shareholder risk. The average beta over the data years is 0.102, implying that union firms have a lower cost of capital and can invest in capital projects with a lower rate of return than nonunion firms. Firms in highly unionized industries also have lower systematic risk, but there is no evidence that beta varies across different industries. Becker and Olson attribute the lower union firm systematic risk to the shifting of market risk to union workers by management, in order to lower the firm's "agency costs" by reducing the cost of monitoring employee performance. The union workers are willing to accept more of the firm's business risk as a means of benefiting from stable (fixed) wage level, but at the expense of more employment variability (layoffs) over the business cycle. After adjusting for lower union firm systematic risk by including the firm's beta as an explanatory variable in the firm's profit rate regression, Becker and Olson estimate that union firms have average a 2 percent lower profit rate over the 1971 to 1980 time period (assuming a 50% union coverage rate). Using industry control, the union profit rate averages 1 percent lower. There is considerable variation by year. Union firm profit rates are significantly lower in 5 of the 11 years of the regression model without industry controls, but significantly higher in 1973 and 1974. In the model with industry controls, union profit rates are significantly lower in only 1971 and 1972 (and not significant in other years).

Becker and Olson (1992) further investigate union firm profitability by looking at excess value of publicly traded firms (market value of shareholders' equity plus the book value of debt minus the ratio of the book value of tangible assets to sales) and price-cost margin (gross operating profits before taxes and depreciation and taxes divided by sales). As in their 1989 paper, Becker and Olson use the firm's beta to adjust the excess value and price-cost margin regressions for systematic market risk. They find a negative union effect on both shareholder wealth (9 percent lower evaluated at a 50 percent union coverage rate) and profits (approximately 2 percent lower). Industry unionization rates do not have significant effect on either excess value or price-cost margin (results from the regression models with two-digit industry controls). Becker and Olson find that negative union effect occurs at a low (0-10 percent category) level of union coverage. At higher union coverage rates (10-20 percent, 20-30 percent, 30-60 percent, and 60 plus percent), the union effect on excess value and price-cost margin is insignificant (the

point estimates are positive in most coverage categories).

Hirsch and Morgan (1994) follow Becker and Olson's (1989) methodology of firm level data, but extend the analysis into the 1980s. They find similar results that union firms have lower systematic risk in the 1970s and early 1980s. The union effect on systematic risk wanes after 1985. Hirsch and Morgan conclude that there is a structural shift in the union effects in the 1980s. Union and nonunion firms have similar systematic risk, suggesting that union firms are no longer shifting market risk to workers and are more profitable than nonunion firms. They argue that the improved collective bargaining environment may be responsible for the improvement in union firm profitability.

A number of studies suggest that a unionized work force may reduce risk exposure from the variability of sales (i.e., market risk). Earle (1988) finds that employment for highly unionized production workers is more than twice more variable as non-production employment and that highly unionized industries are subject to greater output variation than less unionized industries. Earle (1988) Earle and Pencavel (1990), and Brannon (1997) find that the union wage rate and hours of work have a positive correlation and that union workers actually work more annual hours than nonunion workers. Moreover, Earle and Earle and Pencavel find that the increase in hours worked is positively correlated with the size of the union wage differential (i.e., the larger the union wage effect, the greater the difference between union and nonunion hours worked).[7] The positive employment effect on wages and annual hours worked has interesting theoretical implications and implies that unionization may: 1) increase the efficiency of the firm by reducing market risk (i.e., the labor demand shifts out); or 2) union bargaining power is strong enough to force unionized firms off their demand curve.

To the degree that the efficiency gain is associated with risk reduction, the wage and hours worked increase is due to the "union voice" effect generated within the collective bargaining process. The fact that union workers have higher skill sets and lower turnover rates than nonunion workers suggests that union firms have a greater flow and greater certainty of labor services per worker. Greater certainty of labor productivity may echo Becker and Olson's (1989) and Hirsch and Morgan's (1994) findings that union firms have less systematic risk. If work force quality reduces the firm's exposure to market risk, the firm would be willing to compensate workers for the increase in market value associated with reduction in risk exposure. Thus, a portion of the union

wage differential may be a form of an efficiency wage to compensate for less market risk.

Extending this view in the literature that unions may reduce uncertainty over the flow of labor services, we extend the work of Walters (1960) and Ratti and Ullah (1976) and investigate the economic implications for a competitive firm that has the option to hire union or nonunion labor.

III. Union Voice Model

The "union voice effect" as a source of efficiency gains was first hypothesized by F&M. They argue that the collective voice-institutional face of unions facilitates the stabilization of the worker-management relationship. Empirical evidence in support of the union voice effect has established that union sector workers have lower quit rates, giving union firms lower employee turnover (Freeman 1980). The lower probability of quits is attributed to the union voice versus nonunion exit tradeoff. Unions establish and enforce rules on grievance procedures, promotion, unsafe work conditions, etc., and provide a system of industrial jurisprudence through which workers voice their industrial relations problems. Nonunion workers, having no means (or power) to voice their labor-management disputes, must utilize a market response system and exit the firm. The union voice hypothesis has been criticized primarily because there is no formal model that explains how the presence of a union work force increases firm productivity relative to a nonunion work force (Addison (1985), Reynolds (1986)). We address this issue by developing a theoretical model of labor demand under uncertainty that incorporates the propositions found in the union voice literature. The uncertainty model developed here has properties similar to the racial wage disparity model in Adamson and Fausti (2004). The model extends the literature by providing a more detailed conceptual framework to explain why the union voice effect may improve efficiency within the firm.

Lower turnover rates in union firms suggest two efficiency implications. First, union firms should have a higher retention rate of firm-specific skills. Since a lower quit rate reduces hiring and training of replacements, union workers should have greater firm-specific skills on average. Furthermore, if union workers are more willing than nonunion workers to facilitate the introduction of new production technologies (like self-managed work teams and cooperative management teams), union

firms will realize a new form of firm-specific skills. Potentially, union firms could have greater labor productivity due to greater firm-specific skill levels.

Second, lower turnover in union firms should reduce the variance of firm-specific training below that of nonunion firms, which suggests greater certainty about the quality of labor inputs. Nonunion firms, conversely, must hire and train more new workers; at any given point, there is a greater uncertainty of the quality of effective nonunion labor inputs in production. If there is greater certainty over work force quality, then there will be a decrease in the variability of worker productivity, which in turn will increase productive efficiency. Additionally, unions may increase contract efficiency because workers have greater assurance of receiving fair compensation under the explicit rules of a collective bargaining agreement. Consequently, unions may act to decrease uncertainty by decreasing asymmetric information about workers' true productive capabilities. Thus, potential productivity gains from the union voice effect have two sources: 1) higher average firm specific skills, and 2) lower variance in the flow of factor services.[8]

In this paper, we develop union productivity effects associated with a reduction in the uncertainty in the flow of labor factor services.[9] Production under uncertainty fundamentally affects the relationship between factor inputs and productive output. We argue that the theoretical implications of a reduction in the variance in the flow labor factor services due to lower turnover and greater contract efficiency in the union sector are consistent positive union effects on wages and annual hours worked. The reduction in variance of labor quality will be incorporated into a model of competitive firm behavior under production uncertainty. The firm is faced with hiring union or nonunion workers. It is assumed the union does not have monopoly power. Consequently, any union-nonunion differential in wages and employment must derive from increase in labor productivity due to the reduction in the uncertainty over the flow of labor services of union workers relative to nonunion workers.[10]

IV. Assumptions and the Model

The analysis assumes a short-run time frame for the firm. The firm operates in a competitive setting in both the output and factor markets. All inputs are assumed to be fixed except labor. The firm can acquire its labor from one of two separate markets for labor inputs: 1) union; and 2)

nonunion.

Define L to be the quantity of labor acquired for current use and L_1 to be the quantity of labor service actually supplied. It is assumed that L is a decision variable for the firm and L_1 is a random variable. This assumption is based on arguments presented in Walter's (1960, p.325) lucid exposition of why labor supplied is a random variable: "...although the number of workers on the payroll is fixed, the flow of labor services does not stay at one value. It varies from day to day according to weather, sickness, whim, and other accidental influences."[11]

We are interested in the variability in the flow of labor services of union and nonunion labor. We shall assume that Walter's "accidental influences" are identical for both types of labor. However, we argue that the variability in the flow of labor services is higher for nonunion workers due to higher turnover rates, less efficiency in contracting, et cetera. Under this assumption, ceteris paribus, the flow of labor services from union labor is assumed, for simplicity in modeling, to be known with certainty. The flow of labor services from nonunion labor is assumed to be variable.

Following the modeling procedure developed by Ratti and Ullah (1976), L and L_1 are linked in the following way:

$$L_1 = vL, \tag{1}$$

where v is a strictly positive random variable with the variable's density function defined as $f(v)$ with a unit mean.[12] It is assumed that f is thrice differentiable. The firm's short-run production function when it hires union or nonunion labor is defined as:

$$Q = f(L_1) = f(vL), \text{where } f_{L1} > 0 \text{ and } f_{L1L1} < 0. \tag{2}$$

If the firm hires union labor, then v is assumed to be a constant with a value of one. If the firm hires nonunion labor, then v is defined as a random variable, which implies output (Q) is also a random variable.

F&M find that quit rates are lower among union workers than among nonunion workers with comparable skills. Comparable skills imply that the average flows of union and nonunion labor services are equivalent. The unit mean assumption is consistent with the comparable skills assumption. Imposing this assumption on the relationship between union and nonunion labor, we have $L=E[L_1]$. The symbol E denotes the

expectations operator.

Beginning with firm behavior under certainty with respect to the flow of labor services, it is assumed the firm's goal is to maximize profits (Π). The output price of final goods and the input price of labor services and the fixed cost of production are defined respectively as p, w, and C. The firm's profit function is defined as:

$$\Pi = pf(L) - wL - C. \tag{3}$$

The first order condition for profit maximization is:

$$d\Pi / dL = pf_L - w = 0. \tag{4}$$

The second order condition for profit maximization is:

$$d^2\Pi / dL^2 = pf_{LL} < 0. \tag{5}$$

Rearranging equation 4, the following equilibrium condition is arrived at:

$$pf_L = w \quad \text{or} \quad p = w / f_L. \tag{6}$$

Equilibrium condition (6) is the standard result. The firm will pay the labor input its marginal value product (MVP), i.e., its marginal contribution to the production of output.

If the firm hires labor from the nonunion market, then there is uncertainty over flow of factor services from nonunion labor. Profits are now defined in terms of utility. Assuming that the firm's utility function conforms to characteristics of a von Neumann-Morgenstern utility function and its third derivative exists, the firm's expected utility from profits can be written as:

$$E[U(\Pi)] = E[U(pf(L_i) - wL - C)]. \tag{7}$$

It is assumed that the marginal utility of profit is positive $U_{\Pi} > 0$ and that the value of $U_{\Pi\Pi}$ is negative if the firm is risk averse, 0 if the firm is risk neutral and positive if the firm is risk preferring.

The first order condition for maximizing expected utility of profits is:

$$dE[U(\Pi)]/dL = E[U_{\Pi}(pvf_{L1} - w)] = 0. \quad (8)$$

The second order condition is:

$$d^2E[U(\Pi)]/dL^2 = E[U_{\Pi\Pi}(pvf_{L1} - w)^2 + pv^2 f_{L1L1}U_{\Pi}] < 0. \quad (9)$$

V. The Effect of Uncertainty on Firm Behavior

The first question to be addressed in this section is, "how does uncertainty over the flow of labor services affect that firm's level of production as compared to the certainty case?" The certainty case is when the firm hires union labor. The uncertainty case is when the firm hires nonunion labor. This question leads to the first proposition:

PROPOSITION 1. *The firm's expected output when employing nonunion labor, ceteris paribus, is less than the firm's output when employing union labor.*

To establish the above proposition, Jensen's inequality and the definition of expected value are applied to the firm's production function, $f(L_1)$. Certainty in this situation means to replace (L_1) with its expected value, L. Then by the Jensen inequality,

$$E[f(L_1)] < f(L), \quad (10)$$

and proposition I is established.[13] Thus, the implication of the introduction of production uncertainty into the firm's production function is that the mere presence of uncertainty, ceteris paribus, reduces the firm's output as compared to a world of certainty for a given fixed level of labor. Consequently, the model implies that the MPP of L_1 in an uncertain environment is less than the MPP of L_1 if production had taken place at the expected value of the random variable, L_1 (i.e., L or the certainty environment).

The second issue to be discussed is how does input quality uncertainty in conjunction with the firm's attitude toward risk affect the wage paid to labor by the firm.[14] The analysis begins with rewriting equation (8) in the following manner:

$$E[U_{\Pi}(pvf_{L1}) = E[U_{\Pi}]w. \tag{11}$$

Adopting Horowitz's (1970) alternative expression of equation (11),

$$pE[vf_{L1}] = w - \{pCov(U_{\Pi}, vf_{L1}) / E[U_{\Pi}]\}. \tag{12}$$

From equations (11) and (12), the MPP and MVP of nonunion labor are now random variables given by vfL_1 and $pvfL_1$ respectively. Examining the covariance term in equation (12), it is clear that when $U_{III} = 0$, the covariance term is also equal to zero. The implication of equation (12) is that the risk neutral firm hiring labor from the nonunion labor market sets wages equal to $w = E[MVP]$. However, when $U_{III} \neq 0$ the sign of the covariance term can not be ascertained. If it is assumed that the input elasticity of the marginal product curve has an absolute value of less than one, then *sign Cov* = *sign* U_{III}:

$$\varepsilon = (df_{L1} / dL_1)(L_1 / f_{L1}) = L_1 f_{L1L1} / f_{L1} > -1. \tag{13}$$

If equation (13) is true, then examining the derivatives of the two components of the covariance term with respect to v,

$$d[vf_{L1}] / dv = f_{L1}[1 + \varepsilon] > 0. \tag{14}$$

and

$$dU_{\Pi} / dv = U_{\Pi\Pi} pLf_{L1}. \tag{15}$$

verifies that *sign Cov* = *sign* U_{III}. That is, since the sign of equation (15) is dependent on U_{III}, and equation (14) is positive, *sign Cov* must equal *sign* U_{III}.

Applying this result to equation (12), the following condition is arrived at:

$$pE[vf_{L1}] \gtrless w, \text{ and this result is dependent upon } U_{\Pi\Pi} \lessgtr 0. \tag{16}$$

The economic interpretation of these results at the margin are: 1) the risk-neutral firm will hire nonunion labor at a wage equal to its E[MVP];

2) the risk-averse firm will hire nonunion labor at a wage less than its E[MVP]; and 3) the risk-preferring firm will hire nonunion labor at a wage greater than its E[MVP]. The implications of these results are that a firm's input demand for nonunion labor is dependent on its attitude toward risk.[15]

VI. Labor Separation and Wage Differentials

In this section the analysis will begin with the assumption that the firm is risk neutral. As stated above, the supply of labor is segregated into two markets, union and nonunion, and the firm decides from which market it will hire labor. This market structure implies that there are actually two distinct labor markets facing the competitive firm. Thus, across the industry, some proportion of all firms will hire from the union labor market and the remaining firms will hire from the nonunion labor market. All firms will maximize profit by setting MVP=MC. Rearranging equations (6) and (12),

$$p = w / f_{L1} \tag{17}$$

and

$$p = w - \frac{pCov(U_{\Pi}, vf_{L1}) / E[U_{\Pi}]}{E[vf_{L1}]} \tag{18}$$

to simplify the analysis, replace w in equation (18) with w^*. Given that output price p is the same regardless of the input market the firm purchases in, the following equilibrium condition is derived from equations (17) and (18),

$$w / f_{L1} = w^* - \frac{pCov(U_{\Pi}, vf_{L1}) / E[U_{\Pi}]}{E[vf_{L1}]} \tag{19}$$

Equation (19) leads to the second proposition in the paper:

PROPOSITION 2. *For risk neutral firms hiring labor inputs from one of two (worker separated) distinct markets, the firm will hire workers from*

the group with uncertainty about labor quality (flow of labor services) at a lower wage relative to the group whose quality is known with perfect information.

To establish proposition II, it is necessary to establish that the marginal product function, vfL_1, is a concave function. To establish this condition the assumptions of Ratti and Ullah are assumed to hold: 1) $d\varepsilon/dL_1 \leq 0$, and 2) $\varepsilon > -1$.[16] The introduction of the random variable v into the production function results in the production function and the marginal product function being concave functions of v. Equation 14 establishes that the partial derivative of the marginal product function with respect to v is positive. The second partial derivative of marginal product function with respect to v is negative:

$$d^2[vf_{L1}]/dv^2 = \frac{d\{f_{L1}[1+\varepsilon]\}}{dv} = v\{f_{L1L1}(1+\varepsilon) + f_{L1}[d\varepsilon/dL_1]\} < 0. \quad (20)$$

Employing Jensen's inequality the following result is attained:

$$E[vf_{L1}] < f_L. \quad (21)$$

Equation (21) implies that the risk-neutral firm's expected MPP generated by L_1 is less than the MPP that would be achieved under conditions of certainty given the same factor combination. Certainty implies a situation where the random variable v is replaced by its expected value. Due to the greater MPP in the union sector, the union firm's labor demand curve is always greater than the nonunion firm's. Thus, the results derived in equations (19) and (21) imply that w must be greater than w^* for a risk-neutral firm facing a fixed level of labor input. Thus, proposition II is established.[17]

Proposition II demonstrates that when an industry of perfectly competitive firms faces a competitive but segregated labor market structure where the two distinct factor markets vary only in the information available on quality, the result will be a market wage differential between union and nonunion labor. That is, all workers are paid their expected marginal value product. Consequently, union and nonunion workers receive unequal wage rates due to the uncertainty associated with the flow of labor services of nonunion labor. This

proposition presents an interesting and plausible explanation for union wage differentials in the labor market without unions having market power.

If it is assumed that the firm is risk-averse, then equation (19) demonstrates that the degree of wage differentials will increase. This last statement leads to the third proposition of the paper:

PROPOSITION 3. *The size of union wage differential will vary positively with the degree of firm risk aversion.*

To establish proposition III, proposition II is reasserted. Proposition II established that w is greater than w^* for the risk-neutral firm. Then by equations (16 & 19), w^* must be greater than any w^{**}, the price that a risk-averse firm would pay for nonunion labor. Thus, proposition III is established.

VII. A Decrease in Uncertainty over the Flow of Nonunion Labor Services

In this section, the effect of a change in the amount of information available to the firm on the quality of labor services coming from the nonunion labor market is examined. A change in the amount of information available implies a change in the amount of uncertainty associated with nonunion labor. For example, the nonunion turnover rate in a specific industry converges to the union rate. To capture this effect of a marginal change in uncertainty, the distribution of v will undergo a mean preserving change in the dispersion of the distribution. The results developed below are only determinant in the risk-neutral case. A modification of equation (8) is now undertaken by replacing v with $v^* = (\alpha\, v + \beta)$ where α is a shift parameter and β is a function of α with the following properties: a) $\beta' = -E[v] = -1$, and b) $\beta(\alpha=1)=0$. This transformation implies that $L_1 = (\alpha v + \beta)L$. Assuming the firm is risk neutral equation (8) is now:

$$dE[\Pi]/dL = E[pv^* f_{L1} - w] = 0. \tag{22}$$

Replacing v^* with $(\alpha\, v + \beta)$, and renaming equation (22) $E[Z]$,

$$E[Z] = E[p(\alpha v + \beta) f_{L1} - w] = 0, \tag{23}$$

the comparative static analysis can begin. Invoking the implicit function theorem around the equilibrium value of L and α=1, then taking the total differential of $E[Z]$ and setting all of the differentials to zero except dL and $d\alpha$ the partial derivative $\partial L / \partial \alpha$ is:

$$\partial L / \partial \alpha = -E\left[\frac{p(v-1) f_{L1}(1+\varepsilon)}{p(v^*)^2 f_{L1L1}}\right] \tag{24}$$

The sign of the partial derivative derived above can be determined by examining the following relationship:

$$\mathrm{pE}[(v-1) f_{L1}(1+\varepsilon)] = \mathrm{Cov}(v-1), f_{L1}(1+\varepsilon)]. \tag{25}$$

By ascertaining the sign of Cov[(v-1),f_{L1}(1+ε)], the sign of the numerator in equation (25) can be determined. Examining the derivatives of the two components of the covariance term with respect to v,

$$d[f_{L1}(1+\varepsilon)] / dv < 0, \tag{26}$$

and

$$d(v-1) / dv = 1 > 0, \tag{27}$$

verifies that the sign of the covariance is negative. Thus, the sign of the partial derivative $\partial L/\partial \alpha$ is negative. This result leads to the last proposition of the paper:

PROPOSITION 4: *As uncertainty over the flow of labor services for nonunion labor decreases, the nonunion wage paid by firms increase and the union/nonunion wage differential declines.*

To establish the above proposition the implications of $\partial L/\partial \alpha$ are analyzed. The negative sign indicates that as quality uncertainty decreases, demand for L via the nonunion market increases. The implication is that, for a fixed level of nonunion labor, a decrease in uncertainty increases the expected MPP of nonunion labor. This indicates

that $E[vf_{L1}] < E[v^*f_{L1}]$ when $\alpha < 1$. Examining this result in the context of equation (19), we can verify that an increase in the expected MPP of labor hired via the nonunion market will increase w^* relative to w. Thus, the degree of the union wage differential declines as uncertainty declines, and proposition IV is established.

VIII. Wage and Labor Unit Effects

In this section we will discuss the effect of uncertainty over the flow of labor services on firm employment practices. Proposition I established that for a given level of labor input, the firm's expected output will be greater with union labor than for nonunion labor. This result is shown in Figure 1a, a graphical representation of equation (10). The graphical analysis demonstrates that the introduction of uncertainty reduces output from Q^c to Q^u.[18] Proposition II demonstrates that the marginal product of nonunion labor is less than the expected marginal product of union labor. This result is shown in Figure 1b. The graphical analysis shows that the introduction of uncertainty with a fixed level of labor input (L) reduces wages from w to w^*. If we assume an upward sloping market labor supply, w^* is not an equilibrium wage. To restore the equilibrium, the market wage for nonunion labor must rise to $w^u_{r\text{-}a}$, which reduces hours worked in the nonunion sector to $L^u_{r\text{-}a}$. The implication is that in the union sector the relative effects are higher wages and hours worked. Thus, proposition II supports Earle and Pencavel's finding of a positive association between unionization and wages and hours worked and the finding that the magnitude of the union-nonunion hours worked differential increases as the union-nonunion wage differential increases.

Proposition III demonstrates that for a risk-averse firm, the nonunion wage, w^{**}, given a fixed level of labor input, is even lower than the nonunion wage, w^*, for the risk neutral case. In Figure 1b, this effect is represented by the labor demand curve, $MVP^u_{r\text{-}a}$, which is farther to the left of the risk-neutral labor demand curve, $MVP^u_{r\text{-}n}$. Proposition III implies that the union wage differential and the hours worked vary positively with the level of firm risk aversion. Proposition III supports Earle and Pencavel's finding of a greater union effect on hours worked as the union wage effect increases (i.e., the more risk averse the firm the greater will be hours worked and wages paid). Hirsch and Morgan (1994) find evidence that union firms have a lower systematic risk component in their rate of return. This implies that risk-averse firms (which is consistent with lower beta values) may actually view union labor agreements as a management strategy to reduce risk exposure. A risk reduction strategy

may explain the heavy concentration of unions in durable good manufacturing with much higher output fluctuation than other manufacturing industries.

Figure 1.

Proposition IV establishes that the nonunion wage converges to the union wage as uncertainty over the flow of labor services declines. In Figure 1b, this convergence would cause a rightward shift in the risk neutral labor demand curve, $MVP^{u}_{r\text{-}n}$, toward the union labor demand curve, MVP^{c}. Proposition IV is consistent with empirical evidence indicating that progressive nonunion firms, through the use of innovative labor relation practices, can lower the rate of worker turnover and raise wages to near union scale (Foulkes 1980; Freeman and Medoff 1984, chapter 10). Thus, a nonunion firm's use of innovative labor relation practices acts much like an efficiency wage.

Also, proposition IV may provide an alternative explanation of the observed reduction in wage dispersion between skilled and unskilled workers in the union sector relative to the nonunion sector. Earle and Pencavel find the largest union hours worked differential for unskilled laborers. The next largest is for operatives, and the smallest hours worked differential is for skilled craftsmen. Thus, the change in the magnitude of the hours worked union-nonunion differential matches the change in the magnitude of the union-nonunion wage differential as the occupational categories increase in skill. Proposition IV suggests that as the uncertainty about labor quality declines, wages and hours worked will increase. Thus, the union voice mechanism may result in a greater reduction in the uncertainty of labor service flows for less skilled workers than for skilled workers, if it is easier to monitor skilled worker labor service in the nonunion sector than it is to monitor unskilled labor services.

IX. Conclusion

A model of a competitive firm under uncertainty facing competitive output and factor markets is presented. The model assumes nonmonopoly union activity. The paper makes a contribution by providing a conceptual framework for explaining how the union voice effect can increase both union sector wages and hours of employment.

The union voice literature fails to adequately explain the positive correlation between union wages and annual hours worked found by Earle (1988), Earle and Pencavel (1990), and Brannon (1997). The paper links the finding of lower union turnover rates (Freeman (1980) among others) with an increase in the certainty in the flow of labor factor services. The theoretical model demonstrates that a positive union effect on 1) wages

and 2) annual hours of employment is possible when it is assumed that the union voice effect reduces the variability in the flow of labor services for union workers as compared to nonunion workers. This paper makes an additional contribution by merging the literature on competitive firm behavior under uncertainty with the literature on labor union effects.

Proposition 1 demonstrates that the mere introduction of uncertainty over the flow of labor services will reduce firm output, as compared to firm output in a world of certainty about a fixed level of labor input.

Proposition 2 shows that for the risk neutral firm, the introduction of uncertainty over the flow of labor services reduces the marginal productivity of the nonunion labor unit relative to the union labor unit (or the certainty case). Consequently, given a fixed labor unit, the wage received by nonunion workers will be less than the wage received by union workers. At market equilibrium, this implies a positive union wage differential and greater hours worked in the union sector.

Proposition 3 shows that the union wage differential and union hours worked will vary positively with the degree of firm risk aversion, suggesting that the more risk-averse firms become, the greater will be the union wage differential and the union effect on hours worked.

Proposition 4 finds that as the uncertainty between union and nonunion labor quality declines, the union wage and hours worked differential will decline. Thus, with the elimination of uncertainty, the wage and hours worked will be identical for both union and nonunion labor services.

The results demonstrate that it is possible for union activity, by simply reducing the variance in labor service flows, to increase wages and employment without monopoly power. The paper provides a theoretical foundation for the beneficial effects of union activity. We are not dismissing the fact that unions do exert monopoly power. Instead, we assert that unions can have a positive effect on worker wages and hours of work without resorting to monopoly power.

A further extension of the theoretical issues addressed by this study will be pursued by developing the long-run version of the model, as well as an empirical analysis of the testable hypotheses stated in propositions 1 through 4.

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Endnotes

1. For example, Dunlop (1944) hypothesizes that unions set wages to maximize the wage bill.
2. Card (2001) and Card *et al* (2004) find that unionized workers have higher measurable productivity characteristics (e.g., longer tenure, more training and education, etc.) as well as having superior unmeasured skill attributes. Mefford's argument is that lower turnover preserves the higher quality of the union workforce. Nonunion firms have higher turnover, but the quality difference between the departed workers and the new hires does not have a serious deleterious effect on firm productivity.
3. Meta-regression analysis is a regression analysis of the regression estimates of the union productivity effect in the existing pool of studies.
4. Addison and Hirsch argue that the union productivity effect is small if it exists at all. Kuhn argues that there is a small positive union effect in most industries and that the negative effect is primarily in industries with contentious union-management relations. In a majority of cases, the union productivity effect is smaller than the union wage differential.
5. This finding is consistent across alternative measures of profitability. Studies typically use price-cost margin (PMC)=(total revenue-variable costs)/total revenue for industry level data; firm level studies use the rate-or-return on capital (earning/value of capital stock), rate-or-return on sales (earnings/sales), and Tobin's *q* (firm's market value/replacement cost).
6. In efficient capital markets, investors require a lower (higher) rate of return to compensate for lower (higher) relative risk exposure. The risk-adjusted rate of return is the appropriate measure to access the differences in profitability between union and nonunion sectors. If the union sector has a lower degree of relative risk (as found by Becker and Olson (1989)), union firms can have a lower profit rate than nonunion firms and still attract capital investment (relative to the nonunion sector) as long as the union sector's risk-adjusted rate of return is competitive.
7. Boal and Pencavel (1994) find a negative relationship (wage elasticity) between employment and the union/nonunion wage differential. This negative or indirect effect, however, is offset by a positive constant term that Boal and Pencavel refer to as a "direct effect of unionism."
8. The flow of factor services refers to the amount of productive effort a physical unit of labor contributes to the production process. The factor service flow is dependent on the labor unit's skill set (general and firm-specific), labor force experience, education, health, ability, attitude, etc. As established by the literature, the lower employee turnover rates will reduce the loss of highly experience and skilled workers. Because union firms will not have to hire and train new employees at the same rate of nonunion firms, the union sector will have higher levels of and less variance in tenure and firm-specific skills. The higher skill and experience levels alone will increase the flow of labor factor services to the union sector. The argument presented in the theoretical model is that in an environment of production

under uncertainty, the lower variance in union sector skill and experiences levels will also increase the flow of labor factor services and therefore labor productivity.

9. In this model we assume that the expected value of union and nonunion factor service inputs are equal. Nonunion labor, however, is assumed to have greater uncertainty due to a mean preserving increase in the variance of nonunion factor services. We make this assumption in order to preserve a degree of simplicity in the model. We could have assumed that the expected value of union factor service flow was greater than the nonunion expected value (i.e., greater union sector productivity), but the added complexity would not substantially alter the uncertainty model's implications.
10. The exact magnitude of this argument remains an empirical issue and may not be sufficient to explain the entire observed union wage differential.
11. Baldwin (1991) develops a labor market discrimination model based on Walter's discussion of uncertainty over the flow of factor services. However, her discussion of the relationship between marginal productivity and average productivity of labor is flawed. Adamson and Fausti (2004) discuss the flaw in Baldwin's approach and extend the literature by incorporating the issue of risk aversion.
12. The model developed in this paper is a modified version of the model developed by Ratti and Ullah. Ratti and Ullah give credit to Walters (1960), and Roodman (1972) for the method of specification of the input variables.
13. The Jensen inequality states that if a function is strictly concave the following is true: $E\ [h(X)] < h[E(X)]$. See Rao (1973), page 58 for an explanation of Jensen's inequality. Proposition 1 is an established result in the economics of uncertainty literature.
14. Input quality uncertainty refers to increased variability in the flow of labor services.
15. These results concur with the results derived in the paper by Ratti and Ullah (1976). The short-run model of production uncertainty used in this paper to explore the issue of union/nonunion wage differentials was adopted from a paper by Fausti and Feuz (1995). They examine the effect of uncertainty over cattle quality on the purchasing behavior of meatpacking firms.
16. Ratti and Ullah note that this assumption is consistent with many of the common forms of production functions used in the economics profession. If you apply this methodology to a short-run Cobb-Douglas (CD) stochastic production function: $Q = f(L_1) = (L_1)^{\alpha}$ where $L_1 = aL$, $\alpha < 1$, and "a" is a random variable with a range of zero to one, then the elasticity of the marginal product function is equal to: $(\alpha - 1)$. Note that the elasticity value is greater than -1. The derivative $d\varepsilon/dL_1$ is zero, so it is non-increasing. Thus the first derivative of the CD MP function is positive with respect to "a" and the 2nd derivative is negative. Thus, the marginal product function is concave in "a" and the values for $d\varepsilon/dL_1$ and ε are consistent with the R-U assumptions.
17. Proposition II is consistent with the "Theory of Factor Price Disparity" discussed in a paper by Fausti and Feuz (1995). However, Fausti and Feuz assume the third derivative of the production function is negative to justify the assumption that the marginal product function is concave. Assuming a negative third derivative limits the application of the methodology to production functions that adhere to the "Law of Variable Proportions." For a discussion of the Law of Variable Proportions and Production see Chambers (1988). Examples of production functions in the economic literature exhibiting this characteristic are: a) de Janvry (1972) and Halter *et al* (1957). We wish to thank an anonymous referee for making this point.

18. The superscripts c and u denote the certainty and uncertainty cases, respectively. The subscripts r-a and r-n denote the risk averse and risk neutral cases, respectively.